11031

Operating Handbook

Donner Model 21

Wave Analyzer

Serial Number_____

TABLE OF CONTENTS

Subject	Page
Warranty	i
Receiving Inspection	i
Repairs	i
General Description	1
Specifications	1
Circuit Description	2
Installation	3
Operation	3
Maintenance	4
Alignment Procedure	5

ILLUSTRATIONS

Figure	Page
1. Functional Block Diagram	7
2. Schematic	8

WARRANTY

Donner instruments are warranted during a period of one year from date of shipment to original purchaser to be free from defects in material and workmanship. This warranty does not apply to vacuum tubes, except as they are warranted by tube manufacturers. The liability of Seller under this warranty is limited to replacing or repairing any instrument or component thereof which is returned by Buyer at his expense during such period and which has not been subjected to misuse, neglect, improper installations, repair, alteration, or accident. Seller shall have the right of final determination as to the existence and cause of a defect. In no event shall Seller be liable for collateral or consequential damages. This warranty is in lieu of any other warranty, express, implied or statutory, and no agreement extending or modifying it will be binding upon Seller unless in writing and signed by a duly authorized officer.

RECEIVING INSPECTION

Every Donner instrument is carefully inspected and is in perfect working order at the time of shipment. Each instrument should be checked as soon as received. If the unit is damaged in any way or fails to operate, a claim should immediately be filed with the transportation company.

REPAIRS

Whenever a Donner instrument requires service, the nearest Donner representative should be contacted; all representatives will provide immediate service or arrange factory returns when necessary.

Please specify both model and serial number in all correspondence concerning Donner instruments. Address all inquiries on operation or applications of Donner instruments to your nearest sales representative or Sales Manager, Donner Scientific Company, 2829 7th Street, Berkeley 10, California.

GENERAL DESCRIPTION

1.1 The Donner Model 21 Wave Analyzer is a hetrodyne-type frequency-selective voltmeter designed to measure accurately the relative amplitudes and frequencies of spectrum components of an input signal. Accurate readings are obtainable over the frequency range from 30 to 50,000 cps. Two half-lattice crystal filters are used, with either narrow or broad selectivity as controlled by a front-panel switch. This instrument has been designed for versatility and portability, together with simplicity and ease of operation.

SPECIFICATIONS

Frequency Range:	30 to 50,000 cps, continuously adjustable.
Frequency Calibration:	Accurate within 3% ± 10 cps at any setting.
Input Frequency Dial:	16-inch scale length, expanded at low-frequency end.
Input Voltage Range:	Full-scale meter indication with signals 500 volts to 160 microvolts rms. Reference levels between 500 volts and 50 millivolts may be set on the meter to 100% (0 db) by the input attenuators, with the meter range switch at the 100% (0 db) position. The latter then moves in five 10-decibel steps to increase sensitivity for full-scale readings down to 0.3% (-50 db). The lowest usable reading is approximately 0.02% (-70 db).
Voltage Calibration:	Accurate within 5 percent of full-scale.
Residual Distortion:	70 decibels or more below 100% (0 db) level.
Hum and Noise:	Approximately 70 decibels below 100% (0 db) level.
Frequency Selectivity:	(Half-band width): Narrow: 9 cps at 3 db down, 40 cps at 40 db down. Broad: 20 cps at 3 db down, 125 cps at 40 db down. (Narrow is flat-topped; broad is round-topped).
Input Impedance:	200,000 ohms.
Power Requirement:	105-125 volts, 50-60 cps, 45 watts.
Cabinet Dimensions:	14-3/4" wide x 9-1/4" high x 9-1/8" deep.
Weight:	23 pounds (net); 28 pounds (shipping).

CIRCUIT DESCRIPTION

3.1 Figure 1 shows a functional block diagram of the instrument. The amplitude of the input signal which is to be analyzed is set to the reference level by the input attenuators and is fed to the input cathode follower. This cathode follower isolates the input circuit from the rest of the instrument and provides the necessary impedance transformation to feed the input signal to the balanced modulator. A tunable local oscillator, whose frequency is controlled by the main tuning dial, operates below the IF frequency of 395 KC so that the sum of the desired frequency component of the input signal and the local oscillator frequency is always equal to the IF frequency. Thus, the signal component being measured has its frequency transformed to the IF frequency and is amplified and measured at this fixed frequency. Other frequency components present in the input signal transform to other frequencies, which are rejected by the two half-lattice crystal filters. The local oscillator is of the series-tuned type and has its main frequency-determining elements located in a special compartment for isolation from outside disturbances.

3.2 A Type 6AL5 double diode is connected as a series-balanced modulator. Local oscillator signal is coupled to the two diodes through transformer T103. These diodes modulate the input signal current flowing from V101-A through T102, at the local oscillator frequency. Sum and difference frequencies appear at the secondary terminals, the local oscillator signal being balanced out. The input signal itself is too low in frequency to develop any appreciable voltage at the secondary of T102.

3.3 The upper sideband or sum frequency falling at 395 KC passes through Crystal Filter Number 1 to the meter range switch. This switch may be moved in 10 db steps, successively increasing the sensitivity of the instrument to a maximum full-scale sensitivity of -50 db or 0.3% of the reference level. The signal from the meter range switch is amplified by the first IF amplifier stage and then passes through Crystal Filter Number 2, which, being identical to Crystal Filter Number 1, doubles the overall selectivity. Further amplification is provided by the second IF amplifier, the output of which goes to the metering circuits. An amplifier-rectifier type of vacuum-tube voltmeter indicates the resultant signal level on a 4-1/2 inch square panel meter. Two resistance-coupled amplifier stages having approximately 36 db of negative current feedback from the meter movement are used to insure linearity and accuracy of the metering circuit. Plate supply voltage for all tubes is regulated by a Type OA2 voltage regulator tube, to minimize the effects of supply line voltage variations.

INSTALLATION

4.1 No special installation is necessary for the Donner Model 21, beyond connecting the AC line cord to a power source of 105-125 volts, 50-60 cps. Sufficient clearance should be allowed between the instrument and adjacent equipment to assure adequate ventilation. It should be kept in mind when connecting a signal to the input terminals that this is a high gain, high input impedance instrument; care should be used in locating and shielding input leads to avoid picking up stray fields and hum voltages.

OPERATION

5.1 To place the Donner Model 21 in operation, set the METER RANGE switch to the SET LEVEL position, turn the power switch ON, and allow at least fifteen minutes for warm-up.

5.2 With no input signal applied, set the main tuning dial to ZERO and the FINE TUNING knob to the index mark on the panel. Carefully rotate the CALIBRATE knob until maximum indication is obtained on the meter. This procedure adjusts the frequency of the local oscillator to 395 KC, so that the tuning dial calibration will read correctly the frequency of input signal components under measurement. The FINE TUNING control may now be used to facilitate tuning to the desired frequency. However, the FINE TUNING control should be repositioned to index against the panel marker when accurate frequency calibration is desired.

5.3 Next, carefully rotate the BALANCE control knob for a minimum reading, readjusting the CALIBRATE knob for a maximum if necessary. The minimum reading obtained at balance when the local oscillator frequency is thus tuned to the IF frequency should be well below the INPUT LEVEL mark on the meter when the METER RANGE switch is in the SET LEVEL position. This balancing operation nulls out the local oscillator signal appearing in the balanced modulator output, so that this carrier signal will not interfere with the measurement of low frequencies or tend to overload the crystal filters or the IF amplifier stages. The small residual reading (equivalent to less than -80 db) is due to minute fluctuations in line voltage and frequency.

5.4 After the procedures of calibration and balancing have been carried out as described above, the instrument is ready to measure the spectrum components of input signals. With a signal applied to the input terminals, tune the instrument over its entire frequency range to find the input signal component having the largest amplitude. This is usually the fundamental if a single source of signal is present, but it may be of any frequency if measurements are being made of intermodulation distortion or of a multi-channel carrier system.

While tuned to the largest am plitude component and with the METER RANGE switch in the SET LEVEL position, adjust the input level attenuators so that the panel meter reading corresponds to the INPUT LEVEL mark. Turn the METER RANGE switch to the 100% (0 db) position; this signal level now becomes the 100% or zero db reference level, so long as the input attenuators are not disturbed. The main tuning dial may now be adjusted to select the other signal components for measurement of their frequency and amplitude. For these measurements, the METER RANGE switch should be set so that the meter reading at resonance falls between 0 db and -10 db. Percentage readings may be read directly on the appropriate meter scale and db readings will be the sum of the markings on the meter scale and the METER RANGE switch. Either the NARROW or the BROAD position of the selectivity switch may be used. The BROAD position is advantageous when tuning rapidly over the spectrum or when the signals have a small amount of frequency instability, such as those from the reproduction of a recording. The NARROW selectivity position is preferred for improved measurement accuracy when signal components are spaced relatively close together.

5.5 If it is desired to use the instrument as a direct-reading selective voltmeter, a reference signal level corresponding to a known voltage may be used to establish the gain of the instrument. This is done by tuning the wave analyzer to resonance with a sine-wave signal source of known amplitude, such as an audio oscillator or a 60 cps filament supply. The input attenuators are then adjusted so that the meter reading bears a convenient ratio to the known signal voltage. For example, 60% might correspond to 6 volts rms. The instrument would then be operated in the normal manner with the chosen ratio applying to all readings, provided that the input attenuators were not disturbed. Care should be taken to avoid overloading the balanced modulator stage with signals exceeding the 100% level. The effect of such overloading would be to exceed the linear operating range of the modulator, generating non-linear distortion products.

MAINTENANCE

6.1 Except for renewal of the fuse, pilot light or tubes, servicing should be referred to the nearest Donner Scientific Company representative.

6.2 A circuit diagram of the Donner Model 21 is included with this manual for reference purposes.

6.3 To remove the instrument from its case, place the instrument on its face and remove the four 8-32 screws holding the back panel in place. Remove the back panel, then slide the cabinet shell off the instrument, Tubes, wiring and adjustments will now be completely accessible.

6.4 If the Type 6AL5 tube is replaced, it may be necessary to readjust C 121 in order to balance properly the modulator from the front panel. This is done as follows. Turn the SELECTIVITY switch to the BROAD position and the METER MULTIPLIER switch to SET LEVEL. Adjust the CALIBRATE control for maximum meter reading with the main tuning dial set at zero. Adjust the BALANCE control R 139 alternately with C 121 for minimum reading. Repeat these adjustments of CALIBRATE, BALANCE, and C 121 several times until a sharply defined minimum, well below the INPUT LEVEL mark on the meter, is obtained.

ALIGNMENT PROCEDURE

7.1 In the event that it is necessary to re-align the instrument electrically the following procedure should be carefully followed after the instrument is thoroughly warmed up.

7.2 With the CALIBRATE capacitor (C 128) plates half meshed, the main tuning dial set to zero, and the FINE TUNING knob set to the panel index mark, carefully adjust C 128 for maximum meter deflection. The CALIBRATE control will then have the proper range for "zeroing" the local oscillator frequency.

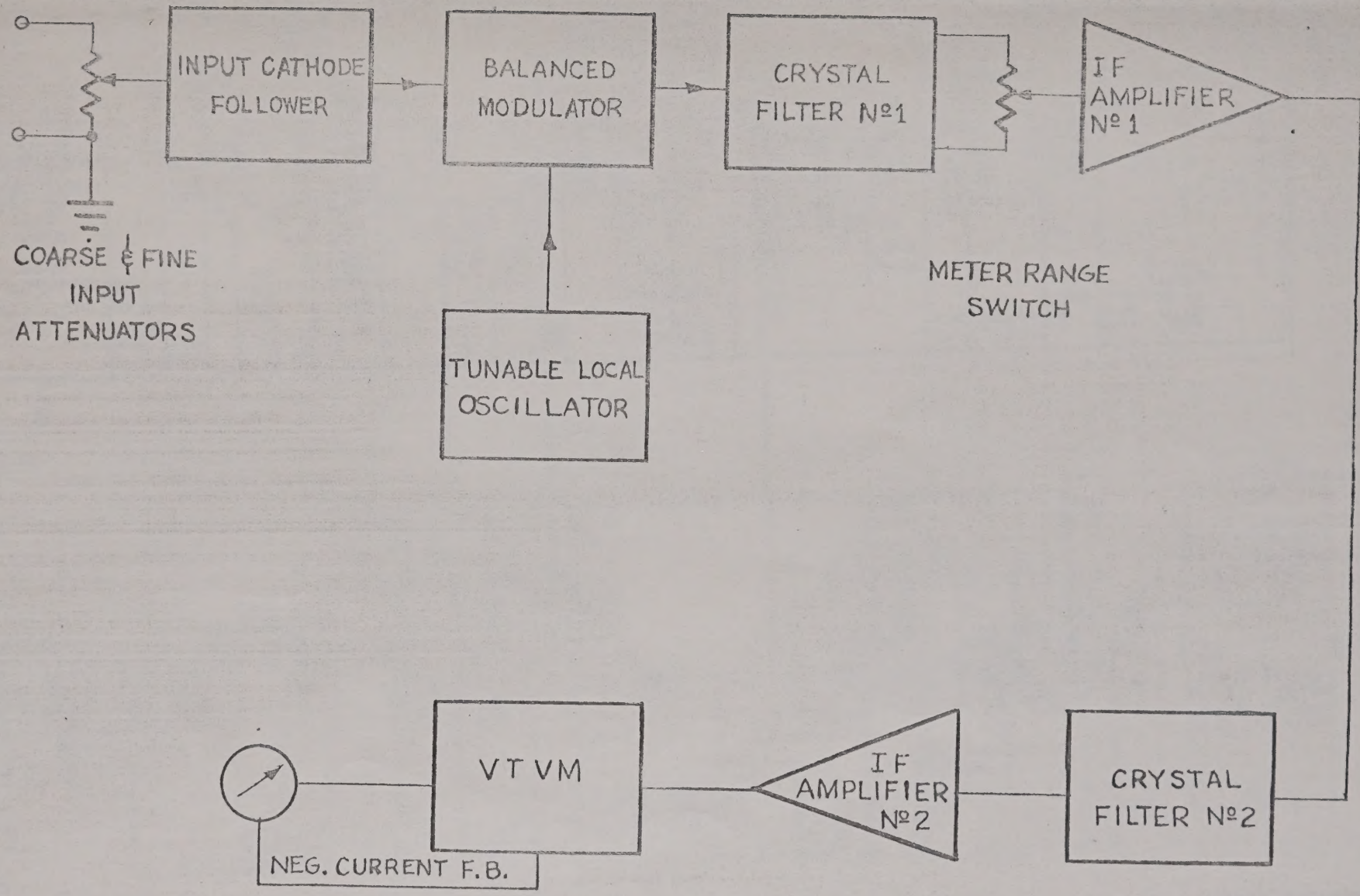
7.3 Carefully adjust the tuning slug of oscillator transformer T 103 for maximum bias voltage on pins 5 and 7 of V 104, which is the Type 6AL5 balanced modulator. This bias voltage should be approximately two volts.

7.4 Next, carefully adjust the tuning slug on modulator transformer T 102 for maximum meter indication. The IF peaking coils L 103 and L 105 may now be adjusted for maximum meter reading. This procedure will result in an approximate alignment by use of the local oscillator signal.

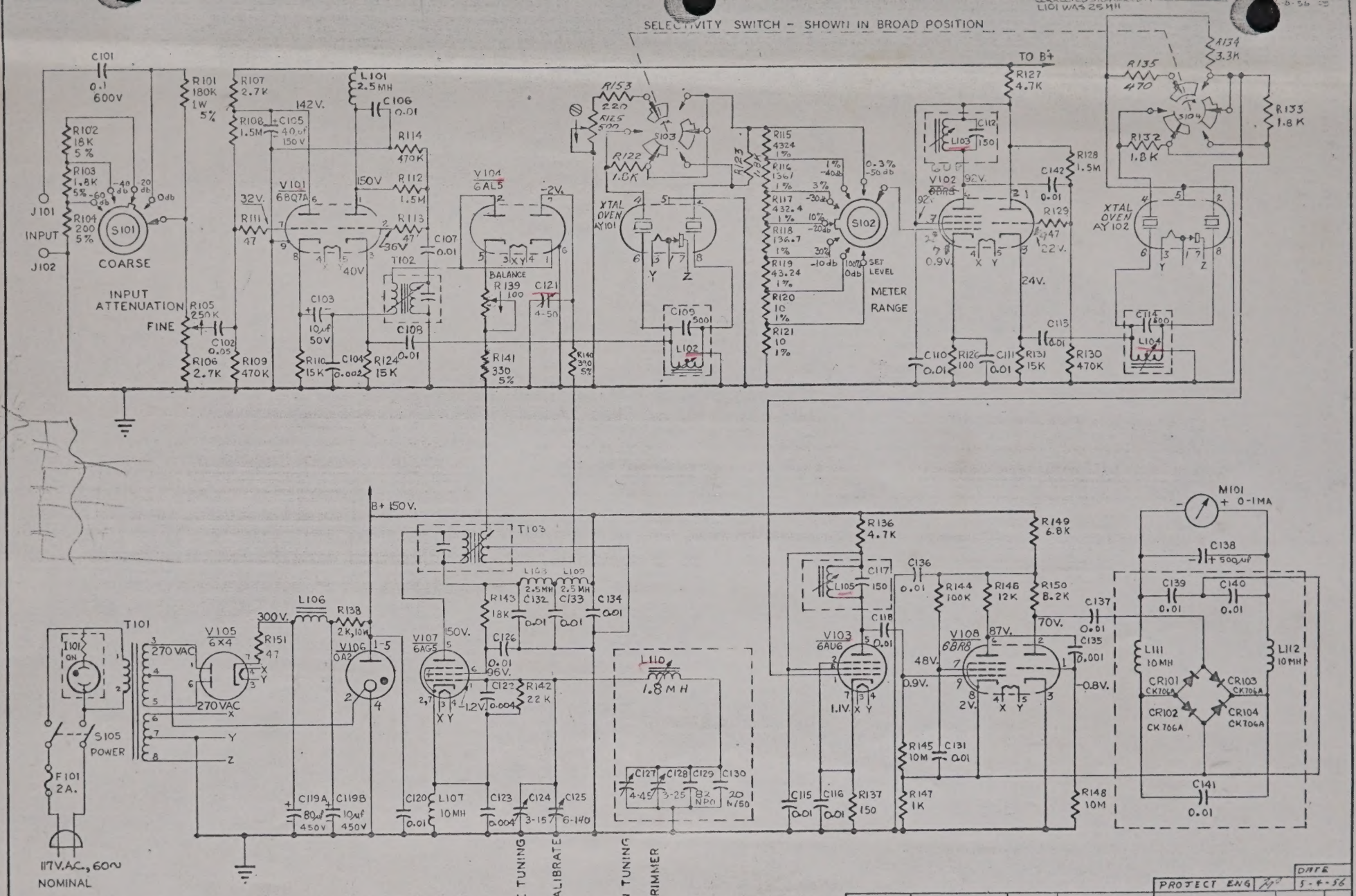
7.5 For a final, more precise alignment the following steps should next be followed: Balance the instrument in accordance with the instructions given in paragraphs 5.2 and 5.3. With the SELECTIVITY switch in the BROAD position, feed a signal of approximately 1000 cps to the input terminals and tune the instrument to the fundamental component of this signal. Adjust the input attenuator so that the meter reads approximately half-scale with the METER RANGE switch in the SET LEVEL position. Next set the alignment adjustments for maximum meter reading in the following order: L 105, L 103, T 102, L 102, L 104. The adjustment of L 102 and L 104 is very broad and it is usually sufficient to set the tuning slugs at the midpoints of their ranges.

7.6 R 125 may be set by first tuning the instrument to resonance with a stable incoming signal, with the SELECTIVITY switch in the BROAD position, and noting the meter reading. Now turn the SELECTIVITY switch to the NARROW position and again tune to resonance. Adjust R 125 to obtain the same meter reading as before. This procedure adjusts the gain of the instrument with NARROW selectivity to the same value as the gain in the BROAD selectivity position.

7.7 As a final check on the operation of the instrument, a measurement should be made of the minimum input signal level which will produce a reading of 100% or zero db, which is the input reference level. If more than 0.05 volt rms is required to reach this level with both input attenuators at their maximum clockwise position, a loss of gain is indicated; this is probably due to defective tubes or need for electrical alignment.



FUNCTIONAL BLOCK DIAGRAM OF MODEL 21 WAVE ANALYZER
FIGURE 1



2. CAPACITANCE VALUES OVER 1 ARE IN μμf; LESS THAN ONE IN μf.
1. RESISTANCE IN OHMS; RESISTORS ½ WATT, 10%.

NOTES: UNLESS OTHERWISE SPECIFIED

DATE 10 NOV. 55	UNLESS SPECIFIED, DIMENSIONS: INCHES TOLERANCES: FRACTIONAL ± 1/64, DECIMAL ± .005, ANGULAR ± ½°		PROJECT ENG.	DATE 5-4-56
DRAWN R.N.				
CHECKED				
APPROVED				
SCALE:		DET. NO. / ITEM / SIZE & MATERIAL OR DWG. NO. / STOCK NO. / QTY.		
MODEL 2100	PART OF:	DONNER SCIENTIFIC COMPANY		
	TITLE SCHEMATIC - WAVE ANALYZER	DRAWING NO. 970	ISSUE E	